SAMPLE CONTENT

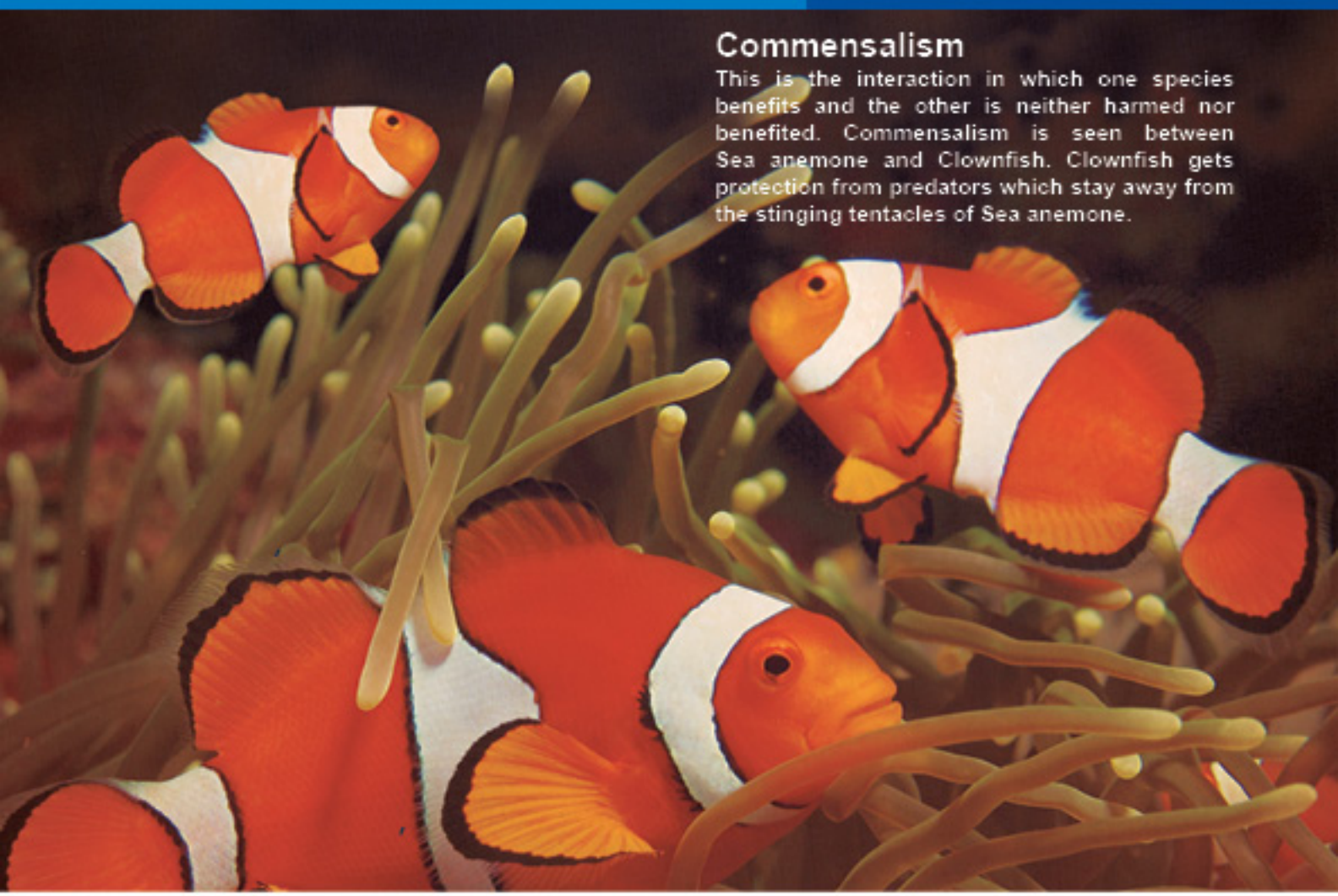
Challenger

NEET-UG

BIOLOGY Vol - II

For all Medical Entrance Examinations held across India.

2223 MCQs with Hints



Commensalism

This is the interaction in which one species benefits and the other is neither harmed nor benefited. Commensalism is seen between Sea anemone and Clownfish. Clownfish gets protection from predators which stay away from the stinging tentacles of Sea anemone.

Target Publications Pvt. Ltd.

For all Medical Entrance Examinations held across India.

Challenger

NEET – UG

Biology Vol. II

Salient Features

- Exhaustive coverage of MCQs under each sub-topic.
- '2223' MCQs including questions from various competitive exams.
- Includes solved MCQs upto NEET-UG 2018, MHT-CET and various entrance examinations from year 2015 to 2018.
- Concise theory for every topic.
- Hints provided wherever deemed necessary.
- Model Test papers for thorough revision and practice.
- Important inclusions: Problems to Ponder.

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PREFACE

Target's '**Challenger Biology: Vol-II'** is a compact guidebook, extremely handy for preparation of NEET-UG exam.

Features of each chapter:

- **Theoretical Concepts** presented in the form of pointers, tables, charts and diagrams that form a vital part of any competitive examination.
- **Multiple Choice Questions** segregated into two sections. **Concept Building Problems** – Contains questions of various difficulty range and pattern. **Practice Problems –** Contains ample questions for thorough revision.
- **Problems to Ponder:** MCQs of different pattern created with the primary objective of helping students to understand the application of various concepts of Biology.

Two **Model Test Papers** are included to assess the level of preparation of the student on a competitive level.

MCQs have been created and compiled with the following objective in mind – to help students solve complex problems which require strenuous effort and understanding of multiple-concepts. The MCQs are a mix of questions based on higher order thinking, theory, and multiple concepts.

The level of difficulty of the questions is at par with that of various competitive examinations like AIIMS, CPMT, TS EAMCET (Med. and Engg.), BCECE, AP EAMCET (Med. and Engg.) and the likes. Also to keep students updated, questions from most recent examinations such as AIPMT/NEET, MHT-CET, K CET, GUJ CET, WB JEEM, of years 2015, 2016, 2017 and 2018 are covered exclusively.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on : mail@targetpublications.org

A book affects eternity; one can never tell where its influence stops.

From,
Publisher

Edition: Second

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Frequently Asked Questions

- **Why Challenger Series?**

  Gradually, every year the nature of competitive entrance exams is inching towards conceptual understanding of topics. Moreover, it is time to bid adieu to the stereotypical approach of solving a problem using a single conventional method.

  To be able to successfully crack the NEET and JEE (Main) examination, it is imperative to develop skills such as data interpretation, appropriate time management, knowing various methods to solve a problem, etc. With Challenger Series, we are sure, you'd develop all the aforementioned skills and take a more holistic approach towards problem solving. The way you'd tackle advanced level MCQs with the help of hints, tips, shortcuts and necessary practice would be a game changer in your preparation for the competitive entrance examinations.

- **What is the intention behind the launch of Challenger Series?**

  The sole objective behind the introduction of Challenger Series is to severely test the student's preparedness to take competitive entrance examinations. With an eclectic range of critical and advanced level MCQs, we intend to test a student's MCQ solving skills within a stipulated time period.

- **What do I gain out of Challenger Series?**

  After using Challenger Series, students would be able to:

  a. assimilate the given data and apply relevant concepts with utmost ease.

  b. tackle MCQs of different pattern such as match the columns, diagram based questions, multiple concepts and assertion-reason efficiently.

  c. garner the much needed confidence to appear for various competitive exams.

- **Can the Questions presented in Problems to Ponder section be a part of the NEET/JEE (Main) Examination?**

  No, the questions would not appear as it is in the NEET/JEE (Main) Examination. However, there are fair chances that these questions could be covered in parts or with a novel question construction.

- **Why is then Problems to Ponder a part of this book?**

  The whole idea behind introducing Problems to Ponder was to cover an entire concept in one question. With this approach, students would get **more variety and less repetition** in the book.

Best of luck to all the aspirants!

02 Sexual Reproduction in Flowering Plants

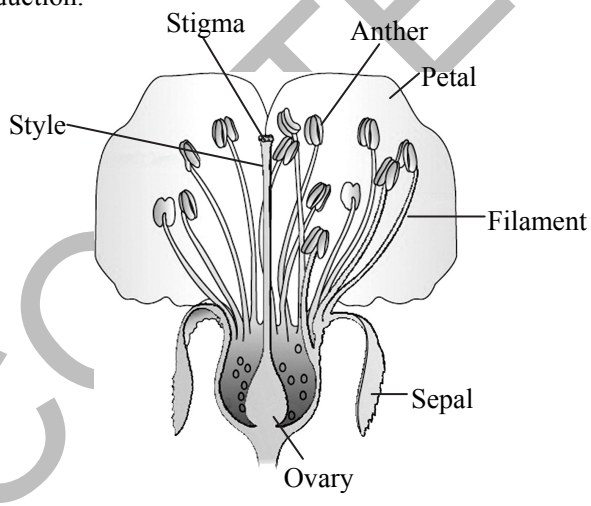
2.1 Flower – A Fascinating Organ of Angiosperms
2.2 Pre-Fertilization: Structures and Events
2.3 Double Fertilization
2.4 Post fertilization: Structures and Events
2.5 Apomixis and Polyembryony

2.1 Flower – A Fascinating Organ of Angiosperms

➢ **Flower:** It is a modified shoot meant for sexual reproduction.

Floral whorls of flowers
- Calyx (Sepals)
- Corolla (Petals)
- Androecium (Stamen)
- Gynoecium (Carpel)

} Reproductive whorls

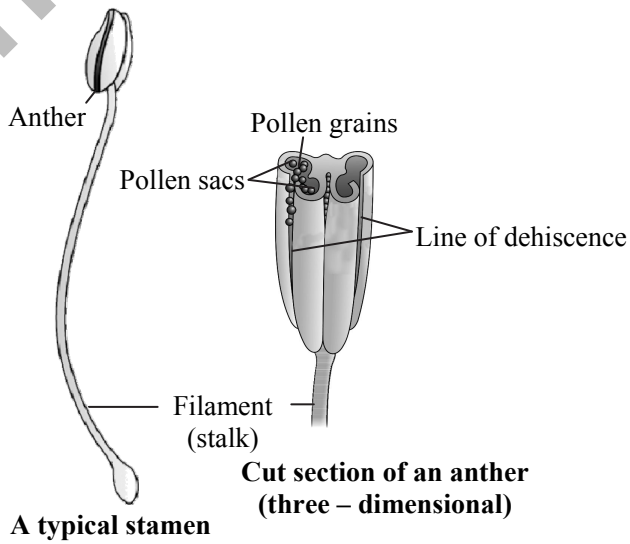


L.S. of a flower showing various parts

2.2 Pre-Fertilization: Structures and Events

Stamen, Microsporangium and Pollen grain

i. Stamen consists of two parts–anther and filament.
ii. Angiospermic anther is bilobed with each lobe having two theca (dithecous).
iii. Each anther lobe generally contains two pollen sacs or microsporangia. Thus, anther is tetrasporangiate.
iv. Numerous microspore mother cells are present in each microsporangium. They are diploid (2n).
v. Microsporangia develop and become pollen sacs.



Cut section of an anther (three – dimensional)

A typical stamen

vi. The microsporangial wall consists of four layers:

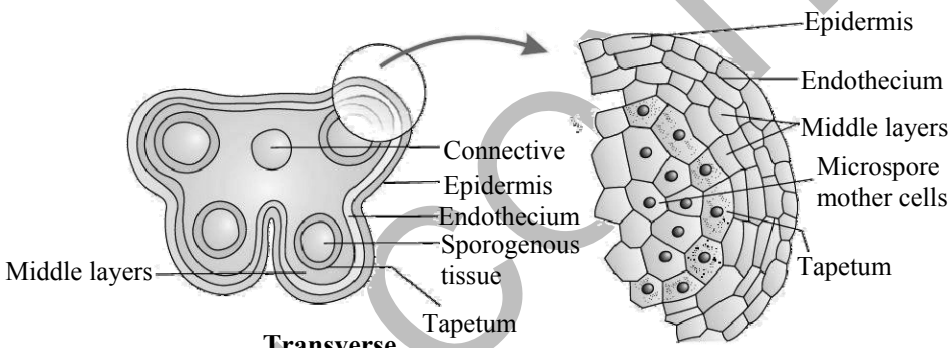
a. Epidermis:
Epidermis is the outermost layer of anther which consists of flattened cells and it is protective in function.

b. Endothecium:
Endothecium is inner to epidermis. It helps in dehiscence of anther.

c. Middle layers:
Below the endothecium, there are 1 – 3 middle layers of parenchyma cells.

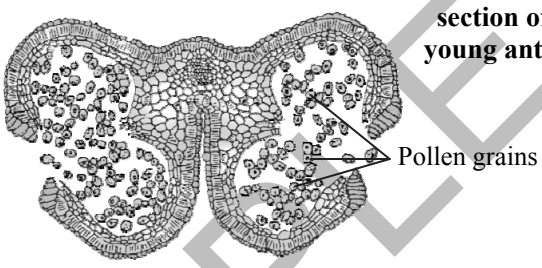
d. Tapetum:
Innermost layer of anther wall is tapetum. It is nutritive in nature. It provides nourishment to the developing pollen grains. The cells of tapetum generally have more than one nucleus and possess dense cytoplasm.

➢ **Microsporogenesis:**
Formation of microspores by the meiosis of diploid microspore mother cells is called microsporogenesis. The compact mass of diploid sporogenous tissue is present inner to the tapetum of microsporangium. Each cell of diploid sporogenous tissue functions as microspore mother cell and undergoes meiosis to form four haploid microspores.
On maturity and dehydration of the anthers, the microspores dissociate from each other and develop into pollen grains which are then released with the dehiscence of anther.



Transverse section of a young anther

Enlarged view of one microsporangium showing wall layers



A mature dehisced anther

➢ **Structure of pollen grain:**

i. Pollen grains develop from the diploid microspore mother cells in pollen sacs of anther.

ii. Pollen grain is haploid, unicellular, uninucleate, spherical structure.
Size: 25–50 μm in diameter

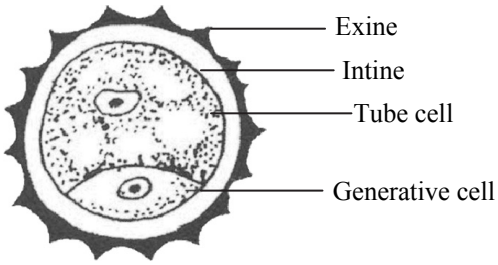
iii. Pollen grain has a double layered wall – outer exine and inner intine.

a. Exine: It is the outer, thick and resistant layer. It is composed of sporopollenin which provides resistance to a pollen grain from high temperatures, strong acids and alkalis.

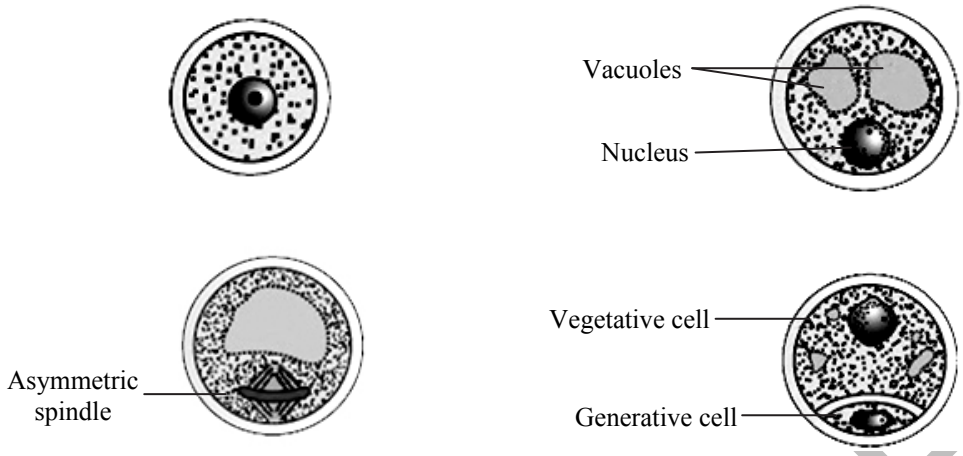
b. Intine: It is the inner layer of sporoderm which is composed of cellulose and pectin.

iv. At certain places of exine, sporopollenin is absent. The thin areas are known as germpore. Pollen grain or microspore is the first cell of male gametophyte or immature male gametophyte.

v. The cytoplasm of pollen grain is surrounded by a plasma membrane. On maturity, a pollen grain contain two cells.



Pollen grain (Sectional view)



Different stages showing maturation of microspore into pollen grain

Mature Pollen Grain

Vegetative cell
- Bigger
- Abundant food reserve
- Large irregularly shaped nucleus

Generative cell
- Small
- Floats in cytoplasm of vegetative cell
- Spindle shaped
- Dense cytoplasm and nucleus

In over 60% angiosperms, pollen grains are shed at the 2-celled stage. In the remaining species, generative cell undergoes mitotic division to produce 2 male gametes before the pollen grains are shed (3-celled stage).

➢ **Harmful effects of Pollen grains:**

i. Pollen grains of many species cause severe allergies and bronchial afflictions leading to chronic respiratory disorders like asthma and bronchitis.

ii. *Parthenium* (Carrot grass) causes pollen allergy.

➢ **Uses /Benefits of Pollen grains:**

i. Rich in nutrients.

ii. Pollen tablets are used as food supplements.

iii. A large number of pollen products in the form of syrups and tablets are available in the market in western countries.

iv. Pollen consumption enhances the performance of athletes and race horses.

➢ **Pollen Viability and Storage:**

i. Viability of pollen grain is highly variable and to some extent depends on the prevailing temperature and humidity.

ii. In rice and wheat, pollengrains remain viable for 30 minutes of their release, whereas in some members of Rosaceae, Leguminoseae, Solanaceae, they remain viable for months.

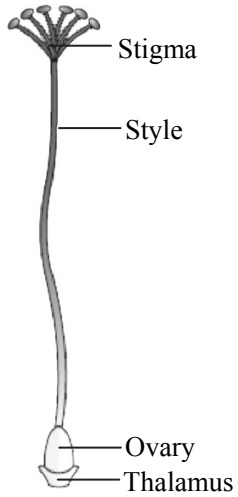
iii. Pollen grains of a large number of species can be stored in liquid nitrogen (–196 °C) for many years.

iv. These stored pollen can be used as pollen banks.

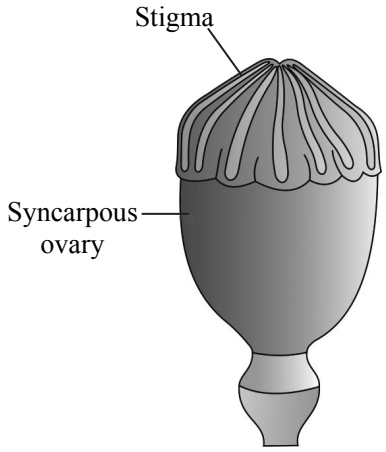
<u>The Pistil, Megasporangium (Ovule) and Embryo Sac</u>

Gynoecium (female reproductive part of a flower) consists of carpels or pistils or megasporophylls. They may be free (apocarpous) or united (syncarpous).

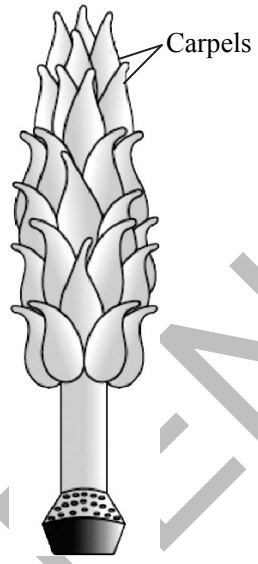
Each carpel has three parts : Ovary, Style and Stigma.



Pistil from *Hibiscus* flower



Multicarpellary, syncarpous pistil (*Papaver*)



Multicarpellary, apocarpous pistil (*Michelia*)

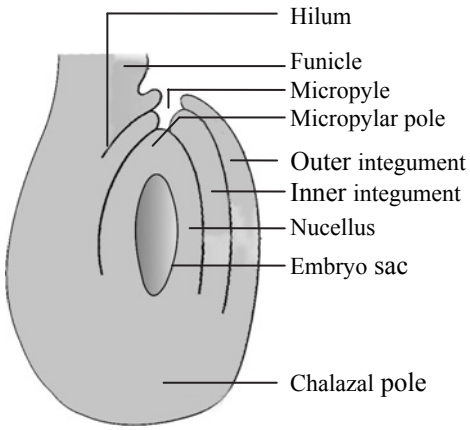
i. Ovary:
It is a swollen portion present at the base and contains one or many ovules which possess female gamete. Inside the ovule, locule (ovarian cavity) is present. Placenta is present inside the locule.

ii. Style:
It is a tube-like structure which posses stigma at its tip.

iii. Stigma:
It is a receptive part of carpel which receives pollen grains during pollination.

iv. Structure of ovule:
Ovule is the integumented megasporangium.
It shows the following structures:

a. Funicle : The stalk of ovule is called funicle which attaches the ovule with placenta.
b. Hilum : The point of attachment of the body of the ovule to the funicle is known as hilum.
c. Integuments : Protective envelopes which encircle the nucellus, except at the micropyle.
d. Nucellus : Mass of cells enclosed within the integuments. They have abundant reserve food material.
e. Chalaza : The basal part of nucellus from where the integuments develop is called chalaza.
f. Micropyle : A narrow opening in the integuments at the terminal end of nucellus is called micropyle.

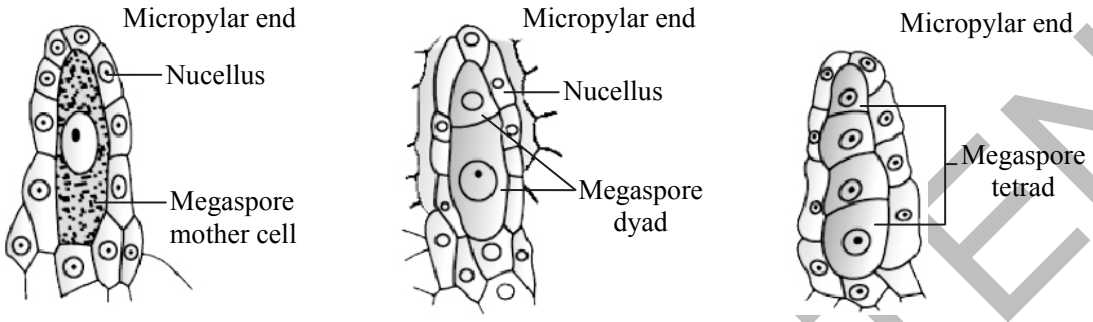


A diagrammatic view of typical Anatropous Ovule

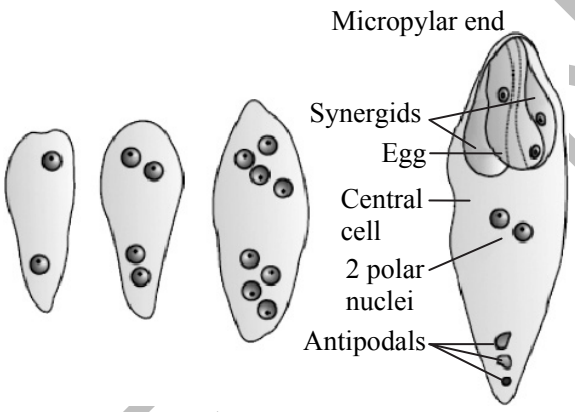
➢ **Development of female gametophyte in angiosperms:**

i. Ovules generally differentiate a single megaspore mother cell (MMC) in the micropylar region of the nucellus.
ii. At maturity, **megaspore mother cell** undergoes meiosis to form four haploid **megaspores,** arranged in a linear tetrad.

iii. The formation of megaspore is called **megasporogenesis.**
iv. Out of the four haploid megaspores, upper 3 (towards micropylar end) degenerate and one at the base remains functional. It is the 1st cell of female gametophyte.
v. The functional megaspore enlarges and undergoes mitotic nuclear division to produce two nuclei.
vi. These nuclei, migrate to opposite poles of the megaspore.
vii. At each pole, nucleus divides twice to form 4 nuclei, 4 at each pole.
viii. The functional megaspore enlarges gradually and becomes 8-nucleate embryo sac.

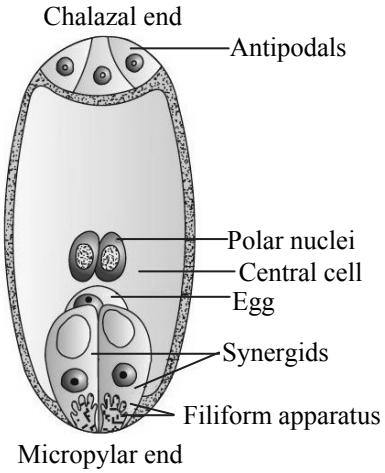


Large megaspore mother cell **Megaspore dyad** **Megaspore tetrad**



Stages of embryo sac (1, 2, 4 and 8 – nucleate)

ix. The two nuclei, one from each pole (polar nuclei) migrate to the centre and fuse to form **diploid secondary nucleus**.
x. The three nuclei at the chalazal end form **antipodal cells** while the three at the micropylar end form **egg apparatus** which consists of one **egg** cell and two **synergids**.
xi. The embryo sac is 7-celled and 8-nucleated.
xii. 6 of 8 nuclei are surrounded by cell walls and organised into cells, the other two nuclei (polar nuclei) are situated below the egg apparatus in the large central cell.
xiii. The development of female gametophyte in angiosperms is completely **endosporic,** i.e. within the megaspore and **monosporic** as female gametophyte develops from a single megaspore. (However in some angiosperms, it may be bisporic or tetrasporic).



Mature Embryo Sac

Pollination

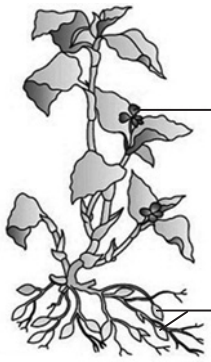
Transfer of pollen grain from anther to stigma is called pollination.
During pollination, stigma receives the pollen.

Types of pollination:

Pollination

- **Autogamy** (Transfer of pollen grains from anther to the stigma of same flower)
  - **Chasmogamous flowers**
    They have exposed anthers and stigma.
  - **Cleistogamous flowers**
    - They do not open at all.
    - When anther dehisce in the flower bud, pollen grains come in contact with stigma and pollination occurs.
    - They are autogamous with no chance of cross pollination.
    - Produce assured seed set even in absence of pollinators.
- **Geitonogamy** (Transfer of pollen grains from anther to the stigma of another flower produced on same plant)
- **Xenogamy** (Transfer of pollen grains from anther to the stigma of another flower produced on a different plant belonging to the same species)

Chasmogamous and Cleistogamous flowers are produced by plants such as *Viola* (common pansy), *Oxalis* and *Commelina*.



Agencies of pollination:

Agents for pollination

- **Abiotic agents**
  i. Wind
  ii. Water
- **Biotic agents (Animals)**
  i. Insects
  ii. Birds

- Anemophily: The transfer of pollen grains through wind is called as anemophily.
- Hydrophily: The transfer of pollen grains through the agency of water is called hydrophily.
  Two types of Hydrophily:
  a. Hypohydrophily: Pollination takes place below the water surface in submerged female flowers.
  b. Epihydrophily: Pollination occurs on the surface of water.
- Entomophily: Pollination through the agency of insects is called entomophily.

Abiotic agencies of pollination:

i. Pollination by wind:

Pollen grains are transferred from anther of one flower to the stigma of another flower by wind. It is considered as the most primitive type of pollination.

Flowers pollinated by wind exhibit following characters:

a. These flowers are unisexual, inconspicuous, colourless, nectarless and odourless.
b. They produce very large quantity of dusty pollens because numerous pollen grains are wasted in this method. Pollen grains are light and non-sticky.
c. Long style of these flowers bear feathery, hairy, sticky and branched stigma to trap pollen grains.
d. Stamens are with versatile and exposed anthers.
   eg. Corn cob, grasses.

ii. Pollination by water:

Pollen grains are transferred from anther of one flower to the stigma of another flower by agency of water.

eg. *Vallisneria, Hydrilla* (Fresh-water) *Zostera* (Marine)

In aquatic plants like water hyacinth and water lily, flowers emerge above the water level and are pollinated by insects or wind.

In *Vallisneria*, female flower reaches the water surface by the long stalk and the pollen grains are released on to the surface of water. Some of the pollen grains reach the stigma of female flowers and thus pollination occurs.

In *Zostera*, female flowers remain submerged in water and pollination takes place inside the water.

Such flowers which are pollinated by water exhibit the following characters:

a. Pollen grains are ribbon-like.
b. They are protected from wetting by a mucilaginous covering.

Biotic agencies of pollination:

Pollen grains are transferred from anther of one flower to the stigma of another flower by agency of insects.

Entomophilous flowers exhibit following characters:

i. Entomophilous flowers are brightly coloured and produce pleasant fragrance.
ii. The nectariferous glands secrete nectar for feeding the visiting insects. Nectariferous glands are positioned such that an insect must touch both the anthers and the stigmas to carry out pollination.
iii. They have spiny exine and sticky stigma.
iv. Floral rewards are usually nectar and pollen grain.
v. When an insect sits on the flowers for harvesting the floral rewards, its body comes in contact with the anthers and stigma.
vi. Due to this, the body of the insect gets covered with the sticky pollen grains. When this insect comes in contact with a receptive stigma it brings about pollination.

e.g.

a. *Amorphophallus* →Tallest flower (6 feet in height) → provides floral rewards as safe place to lay eggs for insects.
b. Species of moth and *Yucca* plant → Both cannot complete their life cycles without each other. Moth deposits eggs in locule of ovary, flower gets pollinated by moth. Larvae of moth come out of the eggs as the seeds develop.
c. Pollen/nectar robbers → These are floral visitors (insect) which consume pollen or nectar without bringing about pollination.

<u>Outbreeding devices and pollen pistil interaction</u>

Outbreeding devices for cross pollination:

Many plants develop outbreeding devices to avoid self pollination, as cross pollination is preferred by majority of flowering plants.

i. Pollen release and stigma receptivity not synchronised:

Pollen is released before stigma becomes receptive or stigma becomes receptive before pollen is released.

ii. Position of anther and stigma:

Both the anthers and stigma are placed at different positions so that pollen cannot come in contact with stigma of the same flower.

Both the above devices prevent autogamy.

iii. Production of unisexual flowers:

In monoecious plants (eg. Castor, maize), autogamy is prevented but not geitonogamy.

In dioecious plants, both autogamy and geitonogamy are prevented.

iv. Self incompatibility:

It is a phenomenon in which genetic mechanism of flower prevents the fusion of gametes of genetically similar plants. This is also called as self-sterility and intraspecific incompatibility.

Pollen pistil interaction:

i. All the events from deposition of pollen grain on the stigma to the entry of pollen tube in the ovule are referred to as pollen pistil interaction.

ii. In cross pollination, there are chances that wrong type of pollen grains may fall on stigma. If wrong type of pollen grain falls on the stigma, post pollination development in the pollen grain does not take place. Stigma recognize only the right type of pollen grain.

iii. Generally, only one pollen tube is formed from a pollen grain (monosiphonous). However, more than one pollen tube may be produced from a pollen grain (polysiphonous).

iv. In self – incompatible pollen grain, some factors on exine may produce rejection response on stigmatic surface.

v. The pistil is adequately equipped with devices to allow the pollen of only right type to function normally, others are discarded.

vi. After reaching the ovary, pollen tube enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus and bursts to release male gametophyte. All these events are part of pollen – pistil interaction.

vii. Incompatibility is the inability of functional male and female gametes to effect fertilization in particular combinations. Incompatibility operates between species (interspecific) as well as within species (intraspecific).

Artificial hybridization → Essential for crop improvement programme.
In crossing experiments, emasculation and bagging are used to prevent contamination of stigma with unwanted pollen.

Emasculation → Removal of anther from the flower bud if the female parent bears bisexual flowers.

Bagging → Emasculated flowers are covered with a bag of suitable size, generally made of butter paper to prevent contamination of stigma by unwanted pollen. When the stigma of bagged flower becomes receptive, mature pollen grains are collected from anthers of the male flower and dusted on the stigma. Such flowers are then rebagged till the fruits develop.
Emasculation is not needed if the female parent bears unisexual flowers.

2.3 Double Fertilization

The fusion of one male gamete with egg and that of another male gamete with secondary nucleus is called as **double fertilization**. It is the characteristic feature of angiosperms.

It consists of two processes:

i. Syngamy:
It is a fusion of first male gamete with egg. It results in diploid zygote which develops to form embryo.

ii. Triple Fusion:
It is a fusion of second male gamete with secondary nucleus. It results in formation of triploid PEN (Primary Endosperm Nucleus) which develops to form endosperm.
Since both male gametes participate in fertilization, it is called double fertilization.

➢ **Process of double fertilization is described as follows:**

i. After pollination, the intine of the pollen grain forms pollen tube and passes through the germ pore.

ii. The pollen tube with two male gametes and tube nucleus runs through the style and finally turns towards the micropylar end of the ovule in the cavity of the ovary.

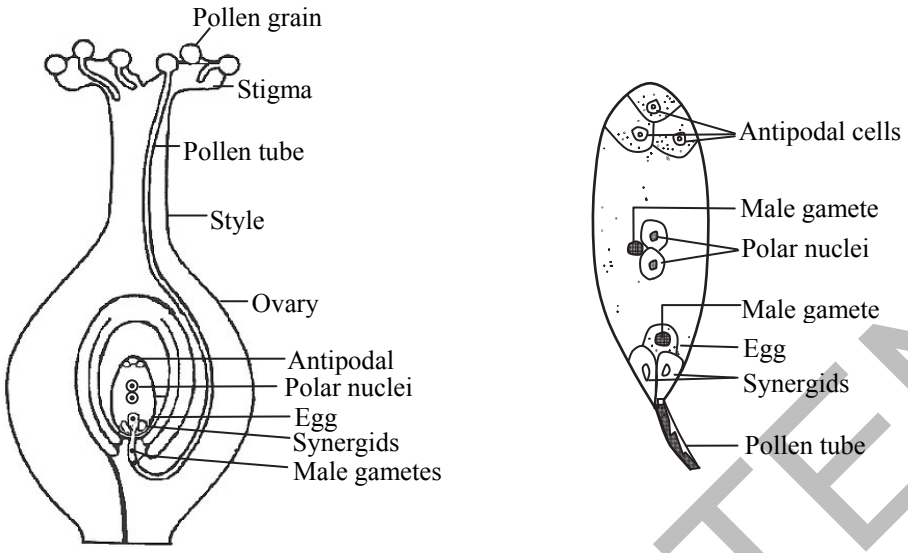
iii. On piercing the nucellus, the pollen tube penetrates the embryo sac and reaches the egg apparatus passing either between the egg and synergids or between one synergid and wall of embryo sac.

iv. Ultimately, the tip of the pollen tube bursts and two male gametes are discharged.

v. One of these male gametes fuses with the egg cell or oosphere causing fertilization, as a result of which diploid oospore or zygote is formed. This is called as **first fertilization or syngamy.**

vi. The other male gamete fuses with the secondary nucleus forming the triploid endosperm nucleus which later on gives rise to endosperm. This is called as **triple fusion or second fertilization.**

vii. Thus, this process of fertilization which occurs twice in the same embryo sac at a time by two male gametes (syngamy and triple fusion) is called **double fertilization.**



Double fertilization in angiosperms

2.4 Post fertilization: Structures and Events

Post fertilization events include development of embryo and endosperm, maturation of ovules into seeds and ovary into fruit.

i. Development of endosperm:

It is a nutritive tissue produced by fusion of secondary nucleus with a male gamete. It provides nutrition to the growing embryo.

Free Nuclear Endosperm:

a. PEN undergoes successive nuclear divisions to form free nuclei.

b. Subsequently, cell wall formation takes place and the endosperm becomes cellular.

c. Coconut water from tender coconut → Free-nuclear endosperm (made up of thousands of nuclei)

d. White Kernel → Cellular endosperm

Endospermic Seed → Endosperm persists in mature seed. It is used up during seed germination.

e.g. Castor, coconut

Non-endospermic Seed → Endosperm is completely used up by the developing embryo.

e.g. Pea, groundnut, bean.

ii. Development of embryo:

a. Embryo develops at the micropylar end of embryo sac where zygote is present.

b. Most zygotes divide only after certain amount of endosperm is formed to assure nutrition to the developing embryo.

c. The early stages of embryo development (embryogeny) are similar in both monocotyledons and dicotyledons.

d. Stages of embryo development: zygote → proembryo → globular, heart-shaped and mature embryo.

e. A typical dicot embryo consists of embryonal axis and two cotyledons.

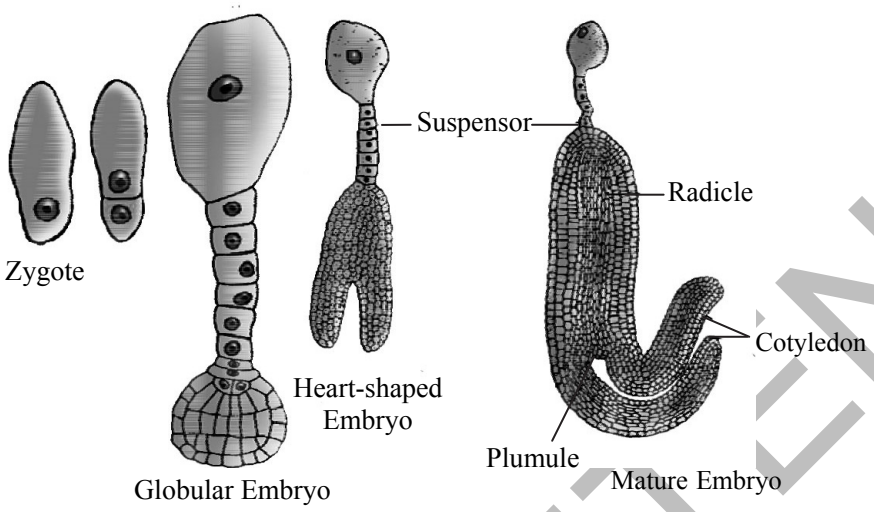
f. Epicotyl → Part of embryonal axis above the level of cotyledons. It terminates with plumule (stem tip).

g. Hypocotyl → Part of embryonal axis below the level of cotyledons. It terminates in radicle (root tip).

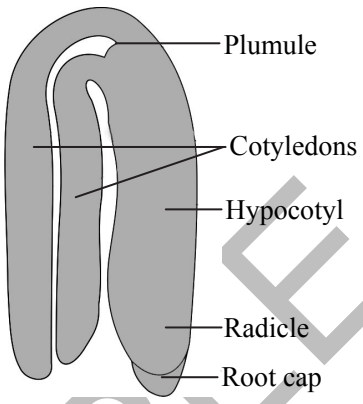
h. Root cap covers the root tip.

i. Embryos of monocot plants (eg. grass family) have only one cotyledon called **scutellum** situated towards one side (lateral) of the embryonal axis.

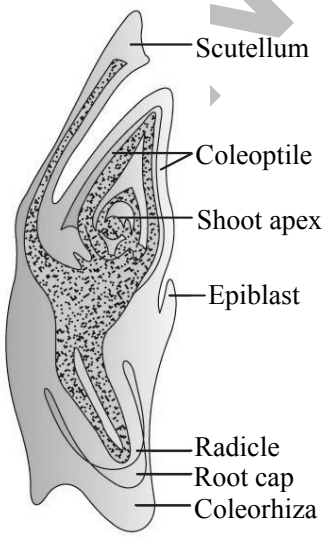
j. Coleorrhiza covers the radical and root cap, while coleoptile encloses few leaf primordia in monocots.



Development of Dicot embryo



Typical Dicot embryo



L.S. of Monocot embryo

iii. Development of seed:

A seed is a ripened fertilized ovule. A seed typically consists of seed coat(s), cotyledon(s) and an embryo axis. Depending upon presence and absence of endosperm, seeds are of two types:

a. Endospermic or albuminous seeds:

These seeds possess endosperm. eg. maize, rice, castor, wheat, barley, etc.

Generally, monocot seeds are endospermic or albuminous.

In some seeds (eg. black pepper, beet), remnants of nucellus are persistent (perisperm).

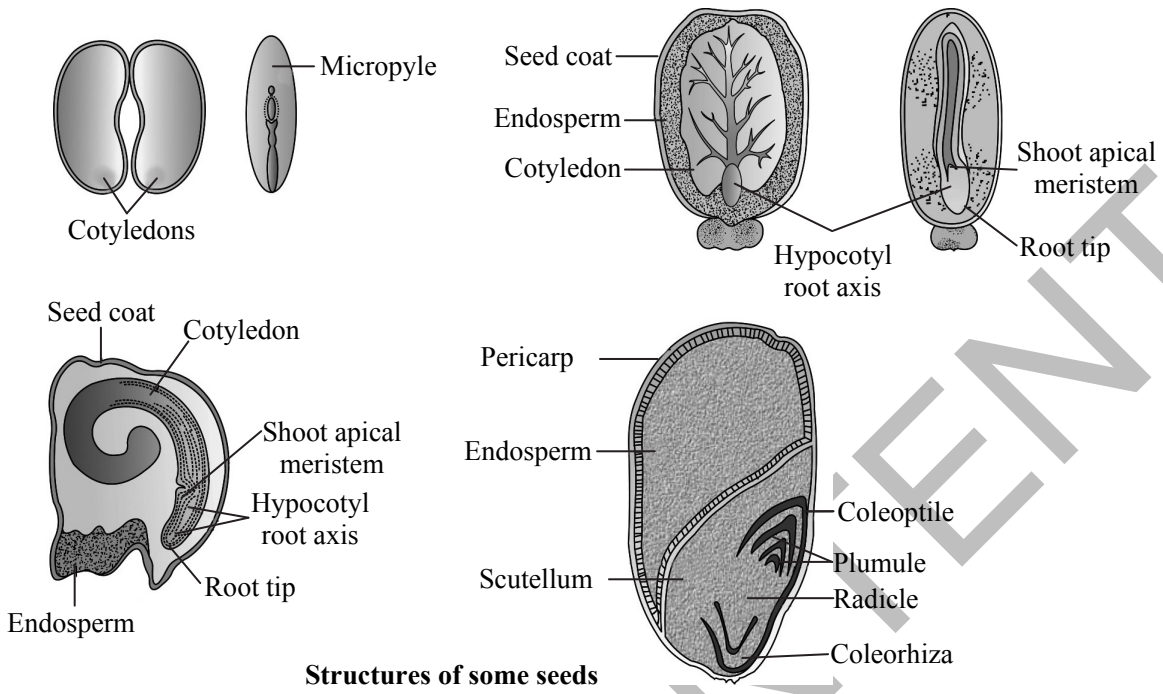
b. Non-endospermic or ex-albuminous seeds:

These seeds do not have endosperm. eg. Pea, beans, groundnut, mustard, etc.

Generally, dicot seeds are non-endospermic.

In non-endospermic or ex-albuminous seeds, cotyledons are thick and fleshy as they store the food.

Though castor is a dicot seed, it is endospermic.



Structures of some seeds

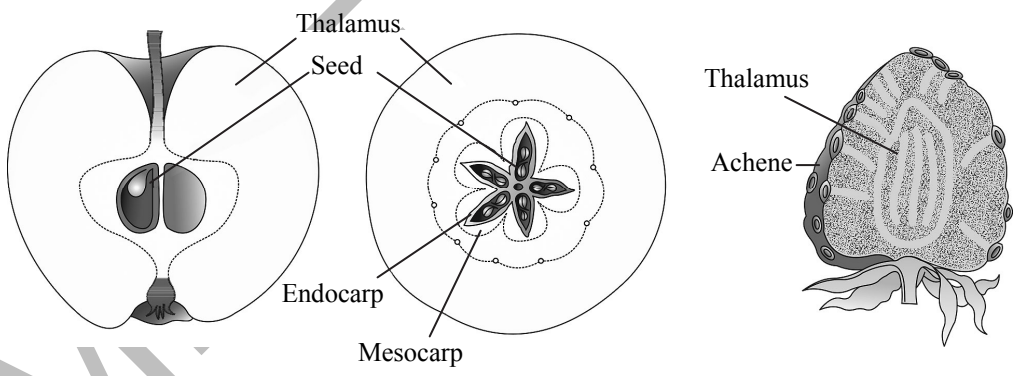
iv. Development of fruit:

a. A fruit is regarded as a mature or ripened ovary.

b. Ovary wall develops to form an outer covering known as pericarp which consists of epicarp, mesocarp and endocarp.

c. A true fruit is one which develops from a single ovary of a single flower. eg. mango

d. A false fruit is one when other floral parts (eg. thalamus) also take part in the formation of fruit. e.g. apple, strawberry, cashew.



False fruits (Apple and Strawberry)

Parthenocarpy:

In this, fruits are developed without fertilization. Hence, fruits are seedless.

Parthenocarpy can be induced through application of growth hormones like gibberellins, e.g. seedless grapes. Banana is an example of natural parthenocarpic fruit.

v. Post fertilization changes:

a. Ovule (megasporangium) forms seed.

b. Ovary (carpel) forms fruit.

c. Egg cells forms embryo.

d. Nucellus forms perisperm.

e. Secondary nucleus forms endosperm.

f. Outer integument forms testa (outer seed coat)

g. Inner integument forms tegmen (inner seed coat)

h. Micropyle forms an opening in the seed (i.e. micropyle)

- **Significance of seed and fruit formation:**

The distribution and dominance of angiosperms on the earth is due to seeds. Success of seeds as propagule is done due to the following characteristics:

i. **Dormancy:**
It is the temporary suspension of growth. One of the factors which control dormancy is presence of certain growth inhibitors in the seeds which prevent germination. During this period, seeds are dispersed at different places.

ii. **Viability:**
It is the functional ability of seeds to germinate after considerable dormancy period. Germination can be delayed till the onset of favourable conditions.

iii. **Reserve food:**
Fully developed embryo is nourished by food stored in either endosperm or cotyledons during germination of seed and a seedling is produced.

iv. **Protective coat:**
The outer, hard seed coat i.e testa gives protection against the mechanical shocks, fluctuations in temperature and dry conditions. Animals eat fruits and either throw away seeds or if consumed, they are not digested due to the hard seed coat and are removed through excreta.

v. **Dispersal:**
Some seeds produce various structures like wings, pappus calyx (persistent and hairy), hooks or sticky substances, and seeds are actively or passively transported to distant places.

vi. **Edible fruits:**
Many fruits are consumed by different organisms and seeds are thrown.
Thus, development of fruits and seeds play a significant role in the spread of the species.

2.5 Apomixis and Polyembryony

i. **Apomixis:**

Apomixis is an asexual mode of reproduction in which new individuals are formed without formation of gametes and their fusion.

It is a form of asexual reproduction that mimics sexual reproduction.

It is commonly seen in grasses and plants of family Asteraceae.

Seeds formed by the process of apomixis are called apomictic seeds.

Apomictic seeds have several advantages in agriculture and horticulture.

Apomictic seeds are formed by following methods:

a. In some species, diploid egg cell is formed without meiosis and develops into embryo without fertilization.

b. In many Citrus and Mango varieties, some nucellar cells which surround the embryo sac start dividing, protrude into the embryo sac and develop into embryos.

ii. **Polyembryony:**

It is the presence of more than one embryo in a seed.

It was first observed by Leeuwenhoek (1719) in citrus.

It is common in lemon, orange, onion, mango, groundnut, etc.

Hybrid seeds:

There has been extensive cultivation of hybrid varieties of many food and vegetable crops which we eat.

Cultivation of hybrids $\longrightarrow$ Increased productivity.

Drawback of hybrids $\longrightarrow$ Hybrid seeds have to be produced every year.

If seeds collected from hybrids are sown, the plants in the progeny will segregate. They do not maintain hybrid characters.

Production of hybrid seed is expensive, hence becomes too costly for farmers.

If hybrids are made into apomicts, then there will be no segregation of characters in the hybrid progeny.

Then, farmers can use hybrid seeds to raise new crop year after year, without buying hybrid seeds every year.

Active research is being carried out across the world in many laboratories to understand the genetics of apomixis and for transferring apomictic genes into hybrids varieties.

Memory Map

SEXUAL REPRODUCTION IN FLOWERING PLANTS

It is the process of development of new plants by the fusion of male and female gametes.

Flower

It is a condensed modified shoot specialized for sexual reproduction in plants.

Androecium

- It is the male reproductive whorl of a flower.
- It is made up of stamens.
- **Stamens** → Filament, Anther

Microsporangium

- The bilobed anther has 4 pollen sacs (Microsporangium).
- Each pollen sac contains diploid sporogenous cells which divide mitotically to to form microspore mother cells.
- Each diploid microspore mother cell (2n) divides meiotically to form four haploid microspores (n) or pollen grains.

Male gametophyte

- The protoplast of pollen grain divides mitotically to form two unequal cells – a small generative cell and large vegetative (tube) cell.
- This is the 2-celled male gametophyte.
- Further development is completed on the stigma after pollination.

Pollination

- It is the transfer of pollen grains (2-celled stage) from anther to the stigma of a flower by means of pollinating agencies.
- **Two types** → Self pollination (Autogamy), Cross pollination (Allogamy)
- **Various pollinating agencies** → Wind (Anemophily), Water (Hydrophily), Insects (Entomophily).

Gynoecium

- It is the female reproductive whorl.
- It is made up of carpels.
- **Carpels** → Ovary, Style, Stigma

Megasporangium

- Ovule is the integumented megasporangium.
- One of the archesporial cells acts as megaspore mother cell and undergoes meiosis to form 4 haploid megaspores.
- Out of these, upper 3 (towards micropylar end) degenerate and only the basal one (towards chalazal end) remains functional.

Female gametophyte

- The functional megaspore undergoes three successive mitotic divisions to form 8-nucleated (7-celled) female gametophyte.
- 2 Synergids, 1 Egg cell, 1 Secondary nucleus, 3 Antipodal cells → Female gametophyte.

Fertilization

- After pollination, pollen grains germinate on the stigma.
- Intine of the pollen grain comes out to form the pollen tube through the germ pore.
- Generative cell of pollen grain divides by mitosis to form, 2 haploid male gametes.
- The pollen tube enters the embryo sac.
- The two haploid non-motile male gametes are brought upto the female gametophyte by means of pollen tube (Siphonogamy).
- The pollen tube burst inside the embryo sac releasing the two male gametes.
- One male gamete (n) fuses with the egg (n) to form diploid zygote (2n) → 1st Fertilization (Syngamy)
- Other male gamete (n) fuses with secondary nucleus (2n) to form Primary Endospermic Nucleus (3n) → 2nd Fertilization (Triple fusion).
- Double fertilization = Syngamy + Triple fusion.

Post-fertilization changes

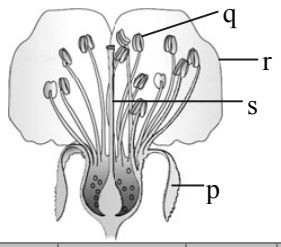
After fertilization, a series of changes take place inside the ovule.

- Ovule (Megasporangium) → Seed
- Ovary (Carpel) → Fruit
- Egg cell → Embryo
- Secondary nucleus → Endosperm
- Ovary wall → Pericarp
- Outer integument → Testa
- Inner integument → Tegmen

Concept Building Problems

2.1 Flower – A Fascinating Organ of Angiosperms

1. Observe the given figure of L.S. of a flower and identify the parts labelled with p, q, r and s.



	p	q	r	s
(A)	Petal	Filament	Sepal	Stigma
(B)	Sepal	Anther	Petal	Style
(C)	Petal	Ovules	Sepal	Stamen
(D)	Sepal	Ovaries	Petal	Stalk

2. Find the odd one from the following.
   (A) Style (B) Stigma
   (C) Stamen (D) Ovary

3. The terminal, generally bilobed structure of a male reproductive organ of flower is
   (A) ovary (B) filament
   (C) pollen grain (D) anther

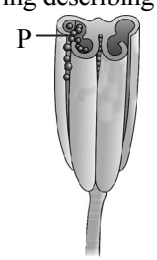
2.2 Pre-fertilization: Structures and Events

Stamen, Microsporangium and Pollen Grain

4. Select the INCORRECT statement about stamen from the following.
   (A) It is male reproductive part of a flower.
   (B) The number and length of stamens remains same in flowers of different species.
   (C) The proximal end of the filament is attached to the thalamus of a flower.
   (D) In some flowers filaments remain attached to the petal of a flower.

5. The microsporangia of anther develop and become
   (A) zoospores (B) pollen sacs
   (C) generative cell (D) MMC

6. Identify part 'P' indicated in the given figure of T.S of an anther and select the appropriate option from the following describing the part 'P' correctly.



   (A) It is formed by mitotic divisions of PMC.
   (B) It represents the male gametophyte.
   (C) It is generally diploid.
   (D) It is formed by the process of megasporogenesis.

7. Which of the following does NOT form the wall of a typical microsporangium?
   (A) Epidermis (B) Tapetum
   (C) Connective (D) Endothecium

8. A typical angiosperm anther is
   (A) bilobed and monothecous
   (B) bilobed and dithecous
   (C) bilobed and athecous
   (D) monolobed and dithecous

9. The wall of a typical microsporangium which nourishes the developing pollen grains is
   (A) tapetum (B) endothecium
   (C) middle layers (D) epidermis

10. Select the INCORRECT statement about tapetum.
   (A) It nourishes the developing pollen grains.
   (B) The cells of tapetum lack cytoplasm.
   (C) The cells of tapetum generally have more than one nucleus.
   (D) It is the innermost wall layer of microsporangium.

11. Endothecium lies between
   (A) tapetum and sporogenous tissue
   (B) middle layers and tapetum
   (C) epidermis and middle layers
   (D) middle layers and sporogenous tissue

12. Which one of the following layer of the anther wall helps in its dehiscence? **[MHT CET 2017]**
   (A) Epidermis (B) Middle layer
   (C) Endothecium (D) Tapetum

13. Each cell of the sporogenous tissue in microsporangium
   (A) is a potential PMC.
   (B) is capable of giving rise to microspore tetrad.
   (C) is a microspore mother cell.
   (D) all the above are true.

14. The outer wall and inner wall of the pollen grain are _____ respectively.
   (A) intine and exine
   (B) exine and intine
   (C) epidermis and endodermis
   (D) None of the above

15. Pollen grains are generally spherical measuring about **[KCET 2017]**
   (A) 25-50 micrometers
   (B) 25-50 millimeters
   (C) 25-50 nanometers
   (D) 25-50 centimeters

16. Pollen grain can withstand high temperature, acid and alkaline conditions due to presence of exine made up of
(A) pectocellulose (B) sporopollenin
(C) cellulose (D) lignocelluloses

17. Select the CORRECT statement from the following.
(A) Sporogenous tissue is haploid.
(B) Endothecium of microsporangium nourishes the developing pollen grains.
(C) The outer three wall layers of microsporangium help in dehiscence of anther.
(D) Epidermis of microsporangium is followed by sporogenous tissue.

18. In pollen grain, sporopollenin is absent in
(A) intine (B) exine
(C) germ pores (D) both (A) and (C)

19. Which of the following has proved helpful in preserving pollen as fossils? **[NEET (UG) 2018]**
(A) Oil content (B) Cellulosic intine
(C) Pollenkitt (D) Sporopollenin

20. Read the statements given below.
i. It is the bigger cell of pollen grain with abundant food reserve.
ii. It has large, irregularly shaped nucleus.
The given statements describe
(A) central cell (B) generative cell
(C) nucellus (D) vegetative cell

21. Which one of the following statements is NOT true? **[AIPMT 2015]**
(A) Pollen grains are rich in nutrients, and they are used in the form of tablets and syrups.
(B) Pollen grains of some plants cause severe allergies and bronchial afflictions in some people.
(C) The flowers pollinated by flies and bats secrete foul odour to attract them.
(D) Honey is made by bees by digesting pollen collected from flowers.

22. Which one of the following statements is NOT true? **[NEET P-I 2016]**
(A) Pollen grains of many species cause severe allergies.
(B) Stored pollen in liquid nitrogen can be used in the crop breeding programmes.
(C) Tapetum helps in the dehiscence of anther.
(D) Exine of pollen grains is made up of sporopollenin.

23. Which of the following statements is NOT correct? **[NEET P-I 2016]**
(A) Pollen germination and pollen tube growth are regulated by chemical components of pollen interacting with those of the pistil.
(B) Some reptiles have also been reported as pollinators in some plant species.
(C) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style.
(D) Insects that consume pollen or nectar without bringing about pollination are called pollen/nectar robbers.

24. If there are 1280 microspores in a tetralocular anther, how many microspore mother cells will be there in its each pollen chamber? **[MH CET 2015]**
(A) 80 (B) 160
(C) 240 (D) 1280

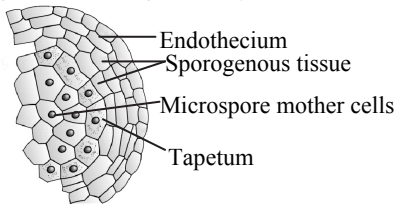
25. In a dithecous anther, each pollen sac contain 1000 MMC. What is the total number of pollen-grains produced by the anther? **[KCET 2016]**
(A) 16,000 (B) 4,000
(C) 32,000 (D) 8,000

26. The development of male gametes in the pollen grains in angiosperms involves **[MHT CET 2018]**
(A) only one mitotic division
(B) two mitotic divisions
(C) both mitotic and meiotic divisions
(D) only one meiotic divisions

27. Among the following statements related to pollens, choose the correct one.
Statement I: In 40% of angiosperms pollen grains are shed at 3-celled stage.
Statement II: Intine is made of cellulose and pectin and it is discontinuous with germ pores. **[KCET 2018]**
(A) Statement I is correct
(B) Statement II is correct
(C) Both statement I and statement II are correct
(D) Both statement I and statement II are incorrect

28. When pollen grain is shed at 3-celled stage, name the cells it contains. **[KCET 2018]**
(A) 1 vegetative cell and 2 male gametes
(B) 2 vegetative cells and 1 male gamete
(C) 2 generative cells and 1 male gamete
(D) 2 male gametes and 1 generative cell

29. Observe the given figure of T.S. of one microsporangium showing wall layers.



The INCORRECTLY labelled part is
(A) Tapetum
(B) Sporogenous tissue
(C) Endothecium
(D) Microscope mother cell

30. Read the given statements and select the correct option.
Statement I: Pollen grains of rice and wheat lose viability after 4 to 5 days of their release.
Statement II: Pollen grains of some members of Rosaceae, Leguminoseae and Solanaceae maintain viability for months.
The CORRECT statement/s is/are
(A) Only Statement I
(B) Only Statement II
(C) Both Statement I and II
(D) None of the statement is correct

31. Pollen grains can be stored for several years in liquid nitrogen having a temperature of **[NEET (UG) 2018]**
(A) –196°C (B) –80°C
(C) –120°C (D) –160°C

The Pistil, Megasporangium and Embryo sac

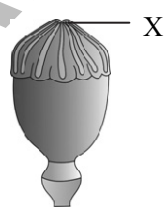
32. Match the Column I with Column II and select the correct option.

	Column I (Terms)		Column II (Description)
i.	Multicarpellary gynoecium	p.	Pistils are free
ii.	Syncarpous ovary	q.	Single pistil
iii.	Monocarpellary gynoceium	r.	Pistils are fused together
iv.	Apocarpous ovary	s.	More than one pistil

(A) i – s, ii – r, iii – q, iv – p
(B) i – r, ii – s, iii – q, iv – p
(C) i – q, ii – p, iii – s, iv – r
(D) i – s, ii – p, iii – q, iv – r

33. The ovule of an angiosperm is technically equivalent to **[NEET P-II 2016]**
(A) megaspore
(B) megasporangium
(C) megasporophyll
(D) megaspore mother cell

34. Observe the given figure of multicarpellary syncarpous pistil of *Papaver*.
Select the option which describes the correct function of part labelled as 'X'.



(A) It contains ovules.
(B) It serves as a landing platform for pollen grains.
(C) It prevents pollen grains from entering the ovary.
(D) It stores food.

35. The elongated slender part beneath the stigma and above ovary is called as
(A) pedicel (B) style
(C) stamen (D) placenta

36. Ovules arise from
(A) stigma (B) placenta
(C) locule (D) integuments

37. Select the ODD one from the following with respect to number of ovules in an ovary.
(A) Papaya (B) Mango
(C) Orchids (D) Water melon

38. Select the INCORRECT pair from the following.
(A) Hilum – Stalk of an ovule
(B) Integuments – Protective envelopes of ovule
(C) Chalaza – Basal part of ovule
(D) Micropyle – Small opening of ovule where integuments are absent

39. The part of megasporangium which have abundant reserve food material is
(A) inner itegument (B) nucellus
(C) placenta (D) hilum

40. Functional megaspore in an angiosperm develops into **[NEET (UG) 2017]**
(A) Ovule (B) Endosperm
(C) Embryo sac (D) Embryo

41. Female gametophyte in angiosperm is represented by
(A) ovule
(B) nucellus
(C) embryo sac
(D) megaspore mother cell

42. The number of synergids and antipodals present in a typical angiosperm embryosac at maturity respectively are **[TS EAMCET 2017]**
(A) two and three (B) one and three
(C) three and two (D) one and two

43. Which of the following is the first cell of female gametophytic generation in Angiosperms? **[MHT CET 2016]**
(A) Megaspore mother cell
(B) Microspore mother cell
(C) Functional megaspore
(D) Egg cell

44. 'X' is the haploid cell of ovule. It divides by mitosis and forms 8 nucleated embryo sac. Identify 'X'.
(A) Egg cell
(B) Polar nucleus
(C) Functional megaspore
(D) Megaspore mother cell

45. Which of the following in embryo sac of angiosperms shows filiform apparatus? **[MHT CET 2016]**
(A) Antipodals (B) Polar nuclei
(C) Egg (D) Synergids

46. Which of the following is NOT a part of egg apparatus?
(A) Egg cell
(B) Filiform apparatus
(C) Synergids
(D) Polar nuclei

47. Egg in female gametophyte is accompanied by **[WB JEEM 2015]**
(A) antipodal cells (B) synergids
(C) definitive nucleus (D) tube nucleus

48. Filiform apparatus is characteristic feature of **[AIPMT (Retest) 2015]**
(A) synergids (B) generative cell
(C) nucellar embryo (D) aleurone cell

49. The pollen grain is related to the embryo sac as
(A) male gametophyte is to the egg.
(B) male gametophyte is to the female gametophyte.
(C) sperm is to the egg.
(D) sperm is to the female gametophyte.

50. If the number of chromosomes in filament of an anther is 14, then what will be the number of chromosomes in each antipodal cell of an ovule of same flower?
(A) 28 (B) 7 (C) 14 (D) 21

51. In a monosporic embryo sac
(A) all the megaspores are functional.
(B) only one megaspore is functional, while other three degenerate.
(C) half of the megaspore are functional.
(D) only one megaspore degenerates, while rest are functional.

52. In majority of angiosperms **[NEET P-II 2016]**
(A) a small central cell is present in the embryo sac.
(B) egg has a filiform apparatus.
(C) there are numerous antipodal cells.
(D) reduction division occurs in the megaspore mother cells.

Pollination

53. Pollination can be defined as the
(A) growth of pollen tube in female gametophyte.
(B) formation of pollen tube by pollen grain.
(C) transfer of pollen grain to the stigma of a pistil.
(D) entry of pollen tube into the embryo sac through synergids.

54. Which of the following statement is TRUE for cleistogamous flowers?
(A) Cleistogamous flowers require pollinating agent for pollination.
(B) Cleistogamous flowers do not open at all.
(C) In cleistogamous flowers cross pollination occurs.
(D) All the given statements are false.

55. Even in the absence of pollinators, assured seed set will be there in **[KCET 2018]**
(A) Chasmogamous flowers
(B) Geitonogamy
(C) Cleistogamous flowers
(D) Xenogamy

56. Autogamy means transfer of pollen grains from
(A) the anther to the stigma of another flower of same plant.
(B) anther to the stigma of a different plant.
(C) the anther to the stigma of same flower.
(D) the anther to the stigma of different flowers with the help of pollinating agents.

57. Which of the following characters is NOT required for autogamy? **[KCET 2017]**
(A) Flowers require synchrony in pollen release and stigma maturation
(B) Anthers and sigma should lie close to each other
(C) Flowers should be bisexual
(D) Required pollination agents

58. Read the given statements and select the correct option.
Statement I: In a normal flower which opens and exposes the anthers and the stigma, complete autogamy is rather rare.
Statement II: Autogamy in a normal flower does not require synchrony in pollen release and stigma receptivity.
(A) Only statement I is correct.
(B) Only statement II is correct.
(C) Both statement I and II are correct.
(D) Both statement I and II are incorrect.

59. Which one of the following statement is correct? **[KCET 2016]**
(A) Chasmogamous flowers never exhibits autogamy.
(B) Chasmogamous flowers always exhibits geitonogamy.
(C) Cleistogamous flowers exhibits both autogamy and geitonogamy.
(D) Cleistogamous flowers always exhibits autogamy.

60. Self pollination which involves two different flowers of the same plant, is called **[MH CET 2015]**
(A) autogamy (B) geitonogamy
(C) xenogamy (D) hybridization

61. Which one of the following is NOT true about self pollination? **[MHT CET 2018]**
(A) A sure method
(B) Most economic
(C) Maintains genetic purity
(D) Favors evolution

62. Which one of the following may require pollinators, but is genetically similar to autogamy? **[AIPMT 2015]**
(A) Geitonogamy (B) Xenogamy
(C) Apogamy (D) Cleistogamy

63. A dioecious flowering plant prevents both **[NEET (UG) 2017]**
(A) Autogamy and xenogamy
(B) Autogamy and geitonogamy
(C) Geitonogamy and xenogamy
(D) Cleistogamy and xenogamy

64. **Assertion:** The flowers produce enormous amount of pollens as compared to number of ovules available for pollination.
Reason: Pollen grains coming in contact with the stigma is a chance factor in both wind and water pollination.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.

65. Which of the following is NOT a characteristic of wind pollinated flower?
(A) Light weight pollen grains
(B) Large and feathery stigma
(C) Sticky pollen grains
(D) None of these

66. Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by **[NEET (UG) 2017]**
(A) Water (B) Bee
(C) Wind (D) Bat

67. Which of the following statement is CORRECT about *Vallisneria, Hydrilla, Zostera*?
(A) These are fresh water plants.
(B) They produce large feathery stigma and non-sticky pollen grains.
(C) These are examples of water pollinated plants.
(D) These plants show cleistogamous flowers.

68. Pollination in water hyacinth and water lily is brought about by the agency of **[NEET P-II 2016]**
(A) bats (B) water
(C) insects or wind (D) birds

69. Select the INCORRECT statement from the following about pollination in sea grasses.
(A) In some species of sea grasses, pollen grains are long ribbon like.
(B) In sea grasses, female flowers floats on water and pollen grains are released inside the flower.
(C) In sea grasses, pollen grains are carried passively inside the water, reaches stigma and the pollination occurs.
(D) In sea grasses, female flowers remain submerged in water and pollen grains are released inside the water.

70. Which of the following is/are the correct characteristic/s of insect pollinated flowers?
(A) Colourful and fragrant flowers
(B) Flowers are rich in nectar
(C) Sticky pollen with rough surface
(D) All of these

71. Attractants and rewards are required for **[NEET (UG) 2017]**
(A) Anemophily (B) Entomophily
(C) Hydrophily (D) Cleistogamy

72. Which of the following are the important floral rewards to the animal pollinators? **[AIPMT 2015]**
(A) Colour and large size of flower
(B) Nectar and pollen grains
(C) Floral fragrance and calcium crystals
(D) Protein pellicle and stigmatic exudates

73. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other? **[NEET (UG) 2018]**
(A) Banana (B) *Yucca*
(C) *Hydrilla* (D) *Viola*

74. What are pollen/nectar robbers?
(A) Insects which carry pollen grain of one flower to another flower.
(B) Floral visitors which consume pollen or nectar without bringing about pollination.
(C) Insects which bring about pollination during night time only.
(D) Pollinators such arboreal rodents.

75. Continued self pollination results in **[KCET 2015]**
(A) formation of unisexual flowers
(B) inbreeding depression
(C) gametes loose vigour
(D) self incompatibility

76. All the events from deposition of pollen grain on the stigma to the entry of pollen tube in the ovule are referred to as
(A) fertilization
(B) conjugation
(C) pollen – pistil interaction
(D) syngamy

77. The inability of functional male and female gametes to effect fertilization is called
(A) compatibility (B) incompatibility
(C) self – sterility (D) prepotency

78. Find out the CORRECT sequence of events taking place in pollen – pistil interaction.
    i. Pollen tube enters one of the synergids and bursts to release male gametes
    ii. Pollen tube enters ovule through micropyle of ovary
    iii. Pollen tube grows through the stigmatic tissue and then style
    iv. Pistil recognizes the correct pollen and accepts it
    (A) iv → iii → ii → i
    (B) iv → ii → iii → i
    (C) i → iv → iii → ii
    (D) iii → iv → ii → i

79. What is NOT true about emasculation of a flower while performing an artificial cross? **[MH CET 2015]**
    (A) It is removal of anthers from flower
    (B) It is done before anthesis
    (C) It is to avoid self pollination
    (D) It is done in flowers of plants selected as male parent

80. Select the INCORRECT statement from the following.
    (A) It is possible to get desired hybrids by manipulating pollen pistil interaction, even in incompatible pollination.
    (B) Yucca plant cannot complete its life cycle without a particular species of moth.
    (C) Self-incompatibility is a genetic mechanism which helps plants to prevent inbreeding.
    (D) Pollen-pistil interaction always results in fertilization process.

81. During artificial hybridization in unisexual flower which of the following is not required?
    (A) Emasculation
    (B) Bagging of female flower
    (C) Dusting of pollen grains
    (D) Both (A) and (B)

2.3 Double Fertilization

82. Double fertilization is exhibited by **[NEET (UG) 2017]**
    (A) Gymnosperms (B) Algae
    (C) Fungi (D) Angiosperms

83. Double fertilization is **[NEET (UG) 2018]**
    (A) Fusion of two male gametes with one egg
    (B) Fusion of one male gamete with two polar nuclei
    (C) Fusion of two male gametes of a pollen tube with two different eggs
    (D) Syngamy and triple fusion

84. In angiosperms, the fusion of male gamete with the secondary nucleus is considered as "second fertilization" because **[MHT CET 2018]**
    (A) it is fusion of two nuclei.
    (B) secondary nucleus is a sister nucleus of the egg.
    (C) it takes place in embryo sac.
    (D) it takes place after pollination.

85. **Assertion (A):** Cellular thickenings at the micropylar tip guide the pollen tubes into the synergids.
    Reason (R): Synergids have antipodals located at the chalazal end.
    Which of the following is true? **[TS EAMCET 2018]**
    (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
    (B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
    (C) (A) is true, but (R) is false.
    (D) (A) is false, but (R) is true.

86. In which of the following plant, double fertilization occurs?
    (A) *Pinus* (B) Fern
    (C) *Marchantia* (D) Maize

87. Select the INCORRECT statement about double fertilization.
    (A) One male gamete fuses with egg cell.
    (B) As a result of fusion of male gamete and egg cell, primary endosperm nucleus is formed.
    (C) The fusion of one male gamete with two polar nuclei is termed as triple fusion.
    (D) Zygote formed as a result of double fertilization develops into embryo.

88. Triple fusion in double fertilization means
    (A) fusion of one male gamete with egg cell.
    (B) fusion of one male gamete with two polar nuclei.
    (C) entry of pollen tube into the synergids.
    (D) release of two male gametes into cytoplasm of synergids.

89. During fertilization when pollen tube enters embryo sac, it has _____ male gamete/s.
    (A) three (B) two
    (C) four (D) one

2.4 Post fertilization : Structures and Events

90. In post fertilization events, free nuclear divisions occurs during development of
    (A) embryo (B) fruit
    (C) endosperm (D) radical

91. During plant tissue culture technique student wants to obtain triploid plant. Which of the following part he should select for culturing?
    (A) Stigma (B) Endosperm
    (C) Anthers (D) Zygote

92. The coconut water from tender coconut represents **[NEET P-I 2016]**
(A) Free nuclear proembryo
(B) Free nuclear endosperm
(C) Endocarp
(D) Fleshy mesocarp

93. Coconut water from a tender coconut is **[AIPMT (Retest) 2015]**
(A) Degenerated nucellus
(B) Immature embryo
(C) Free nuclear endosperm
(D) Innermost layers of the seed coat

94. In angiosperms, during development of embryo, the suspensor cells develop from **[MH CET 2015]**
(A) oospore (B) integument
(C) endosperm (D) cotyledon

95. Select the INCORRECT pair from the following.
(A) Albuminous seed – Pea
(B) Non-albuminous seed – Groundnut
(C) Perisperm – Persistent nucellus
(D) Scutellum – Cotyledon in grass family

96. The hilum is a scar on the **[AIPMT 2015]**
(A) Seed, where funicle was attached
(B) Fruit, where it was attached to pedicel
(C) Fruit, where style was present
(D) Seed, where micropyle was present

97. Endosperm nucleus is **[WB JEEM 2015]**
(A) n (B) 2n (C) 3n (D) 4n

98. Select the INCORRECT pair from the following.
(A) Dormancy – Inactive embryo
(B) Parthenocarpic fruit – Cashew
(C) False fruit – Apple
(D) Pericap – Fruit wall

99. Morphologically the white fluffy edible mass in maize is
(A) seed coat (B) seed
(C) endosperm (D) pericarp

100. The wheat grain has an embryo with one large, shield-shaped cotyledon known as **[AIPMT (Retest) 2015]**
(A) Coleoptile (B) Epiblast
(C) Coleorrhiza (D) Scutellum

101. Which one of the following fruits is parthenocarpic? **[AIPMT (Retest) 2015]**
(A) Banana (B) Brinjal
(C) Apple (D) Jackfruit

102. Banana is an example of **[WB JEEM 2015]**
(A) parthenocarpy (B) apomixis
(C) parthenogenesis (D) polyembryony

103. **Assertion (A):** All the fruits that we eat are not real fruits.
Reason (R): In few plants floral parts like thalamus or pedicel also contribute to the fruit formation. Such fruits are called false fruits. **[EAMCET 2016]**
(A) A and R are true and R is the correct explanation of A.
(B) A and R are true and R is not the correct explanation of A.
(C) A is true, R is false.
(D) A is false, R is true

104. Match the following ovular structure with post fertilization structure and select the correct alternative.

i.	Ovule	a.	Endosperm
ii.	Ovary	b.	Fruit
iii.	Nucellus	c.	Seed
iv.	Polar nuclei	d.	Perisperm

(A) i – b, ii – c, iii – d, iv – a
(B) i – b, ii – c, iii – a, iv – d
(C) i – c, ii – b, iii – d, iv – a
(D) i – c, ii – b, iii – a, iv – d

105. The ability of seeds to retain the power of germination over a period of time is called
(A) dormancy of seed (B) viability of seed
(C) drying of seed (D) totipotency

106. Seeds without fertilization is obtained from **[KCET 2015]**
(A) Polyembryony (B) Parthenocarpy
(C) Dormancy (D) Apomixis

107. Which character of angiosperms helped in their dominance on earth? **[MHT CET 2018]**
(A) Formation of seeds
(B) Formation of endosperm
(C) Double fertilization
(D) Presence of xylem vessels

2.5 Apomixis and Polyembryony

108. The phenomenon of replacement of sexual reproduction with asexual reproduction is called **[TS EAMCET 2017]**
(A) Vivipary (B) Apomixis
(C) Karyogamy (D) Syngamy

109. In some species of family Asteraceae seeds are produced without fertilization. It is called as _____ **[MHT CET 2017]**
(A) apomixis (B) amphimixis
(C) parthenocarpy (D) vivipary

110. Seed formation without fertilization in flowering plants involves the process of **[NEET P-I 2016]**
(A) Somatic hybridization
(B) Apomixis
(C) Sporulation
(D) Budding

111. Polyembryony in nothing but
(A) occurrence of more than one seed in a fruit.
(B) occurrence of multiple seeds without embryos.
(C) occurrence of two or more embryos in one ovule.
(D) the fruit formed as a result of parthenocarpy.

Miscellaneous

112. Microsporogenesis is nothing but
(A) formation of microspores
(B) formation of female gametophyte
(C) dehiscence of anther
(D) development of megaspore mother cell

113 In an angiosperm a female plant having 2n = 24 is crossed with a male plant having 2n = 12. What will be the chromosome number of the endosperm? **[MHT CET 2016]**
(A) 12 (B) 18 (C) 24 (D) 30

114. A plant produced 50 flowers. Ovary of each flower has 50 ovules. How many fruits and seeds are produced by that plant respectively? **[EAMCET 2016]**
(A) 50, 50 (B) 50, 100
(C) 50, 2500 (D) 2500, 2500

115. Which one of the following generates new genetic combinations leading to variation? **[NEET P-II 2016]**
(A) Nucellar polyembryony
(B) Vegetative reproduction
(C) Parthenogenesis
(D) Sexual reproduction

116. In angiosperms, microsporogenesis and megasporogenesis **[AIPMT (Retest) 2015]**
(A) occur in ovule
(B) occur in anther
(C) form gametes without further divisions
(D) involve meiosis

117. Which among these is not a post fertilization event? **[KCET 2016]**
(A) Fruit formation
(B) Gametogenesis
(C) Seed formation
(D) Embryogenesis

118. If the cells of the nucellus in the angiosperm ovule, contains 24 chromosomes, what will be the number of chromosomes in the endosperm of a self pollinated flower? **[MHT CET 2017]**
(A) 12 (B) 24 (C) 36 (D) 48

Practice Problems

2.2 Pre-fertilization: Structures and Events

Stamen, Microsporangium and Pollen Grain

1. Identify X, Y, Z and complete the given statements by selecting the correct option.
i. A typical angiosperm anther is ‘X’.
ii. Each anther lobe has two theca, hence they are called ‘Y’.
iii. The anther is a tetragonal structure consisting of four ‘Z’.

	‘X’	‘Y’	‘Z’
(A)	Sometimes sterile	Tetraspore	Megasporangia
(B)	Monolobed	Bilobed	Pollensac
(C)	Always fertile	Tetrasporangiate	Tetrasporangia
(D)	Bilobed	Dithecous	Microsporangia

2. Which of the following cannot be observed in the anther which is ready for dehiscence?
(A) Connective
(B) Sporogenous tissue
(C) Pollen grains
(D) Epidermis

3. Select the INCORRECT statement about sporopollenin.
(A) Pollen grains are well preserved as fossils due to presence of sporopollenin.
(B) Sporopollenin is the most resistant organic material.
(C) Only enzymes can degrade sporopollenin.
(D) Sporopollenin is absent at germ pores.

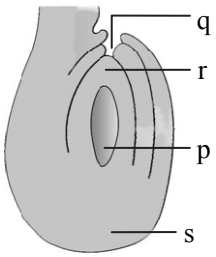
4. All the below given statements are true about pollen grains, except
(A) pollen grains are rich in nutrients.
(B) not all pollen grains are beneficial for human, some of them often lead to chronic respiratory disorders.
(C) pollen grains loose their viability after shedding from anther, thus they cannot be stored for longer period.
(D) in western countries, people use pollen tablets as food supplements.

The Pistil, Megasporangium and Embryo sac

5. Identify ‘p’, ‘q’, ‘r’ and ‘s’ in the given statements by selecting the CORRECT option.
i. The basal bulged part of the pistil is the ‘p’.
ii. The elongated slender part beneath the stigma is called ‘q’.
iii. ‘r’ arise from the placenta which is located inside the locule.

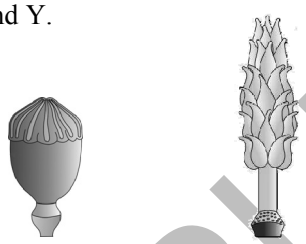
	p	q	r
(A)	Thalamus	Filament	Ovary
(B)	Style	Funicle	Megasporangia
(C)	Ovary	Style	Ovules
(D)	Pistil	Micropyle	Female gametes

6. Observe the given figure of a typical anatropous ovule and identify the labels p, q, r, s by selecting the correct option.



	'p'	'q'	'r'	's'
(A)	Embryo sac	Micropyle	Micropylar pole	Chalazal pole
(B)	Ovule	Hilum	Funicle	Thalamus
(C)	Nucellus	Germpore	Micropylar pole	Distal pole
(D)	Egg	Funicle	Chalazal pole	Micropylar pole

7. Identify the type of pistils given in the figure X and Y.



	X	Y
(A)	Monocarpellary apocarpous	Multicarpellary syncarpous
(B)	Multicarpellary syncarpous	Multicarpellary apocarpous
(C)	Monocarpellary syncarpous	Monocarpellary apocarpous
(D)	Multicarpellary apocarpous	Monocarpellary apocarpous

8. Which of the following is the CORRECT sequence of formation of the embryo sac?
   (A) Functional megaspore → Meiotic division → 4 nucleate embryo sac → 2 nucleate embryo sac → Egg cell
   (B) Meiotic division → Non-functional megaspore → Central cell → Mitotic division → 2 nucleate embryo sac → 4 nucleate embryo sac
   (C) Functional megaspore → Mitotic division → Two nuclei → Opposite poles → 2 nucleate embryo sac → 4 nucleate embryo sac → 8 nucleate embryo sac
   (D) Mitotic division → 4 nucleate embryo sac → Mitotic division → 8 nucleate embryo sac → Opposite pole → Antipodals and egg apparatus

9. Select the CORRECT statement from the following.
   (A) At maturity, a typical angiosperm embryo sac is 7 nucleated and 8 celled.
   (B) Egg apparatus consists of one egg cell, two synergids and three antipodals.
   (C) The nucleus of functional megaspore first divides meiotically to produce 4 nucleate embryo sac and then mitotically to produce 8 nucleate embryo sac.
   (D) Filiform apparatus present on synergids plays an important role in guiding the pollen tube.

10. The number of meiotic and mitotic divisions required to form a mature embryo sac from megaspore mother cell are _____ and _____ respectively.
   (A) one, two (B) two, three
   (C) two, one (D) one, three

Pollination

11. Read the given statements and select the correct option.
   i. Cleistogamous flower produce assured seed-set even in the absence of pollinators.
   ii. Majority of plants use abiotic agents for pollination.
   iii. Wind pollination is more common amongst abiotic pollinations.
   iv. Geitonogamy is functionally self-pollination but, genetically it is cross pollination as pollen grains come from different flower.

   The INCORRECT statements are
   (A) i and iv (B) ii and iv
   (C) i and iii (D) only iv

12. In which of the following types of plants, both autogamy and geitonogamy can be prevented?
   (A) The plants which are dioecious and bear either male or female flowers.
   (B) The plants which are monoecious and bear bisexual flowers.
   (C) The plants which are monoecious and bear unisexual flowers.
   (D) The plants which are dioecious and bear bisexual flowers.

13. Read the given statements and select the correct option.
    i. Pollination by water is quite common in flowering plants.
    ii. Wind pollinated flowers often have a single ovule in each ovary.
    iii. In aquatic plants such as water hyacinth and water lily flowers are submerged in water and pollen grains are released inside the water.
    iv. In most of the wind pollinated flowers, pollen grains are covered by mucilaginous covering.
    (A) Only statements ii and iii are correct.
    (B) Only statements i and iii are incorrect.
    (C) Only statement ii is correct.
    (D) Only statements iii and iv are incorrect.
14. In which of the following case autogamy will be prevented but not geitonogamy?
    (A) When both male and female flowers are present on the same plant.
    (B) When plant is dioecious.
    (C) When male and female flowers present on different plants.
    (D) Both (B) and (C)

2.3 Double Fertilization

15. Identify the part labelled as 'X' in developing embryo of dicot and select the CORRECT statement about it.

    (A) It is radical which further develops into the root.
    (B) It is zygote embedded into embryonic tissue.
    (C) It is plumule which further develops into the shoot.
    (D) It is cotyledon which contains reserve food.
16. Read the given statements about double fertilization and select the correct option.
    i. Pollen tube discharge its gametes in antipodal cells.
    ii. In angiosperm, triple fusion is necessary for formation of embryo.
    iii. The number of nuclei taking part in double fertilization is 5.
    iv. The fertilization of egg takes place inside embryo sac.
    The CORRECT statements are
    (A) i and iii (B) iii and iv
    (C) ii and iv (D) i and ii

2.4 Post fertilization : Structures and Events

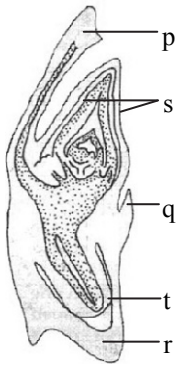
17. In _____, endosperm is completely consumed by developing embryo before seed maturation, whereas in _____, it persists in the mature seed.
    (A) castor, groundnut
    (B) pea, beans
    (C) beans, castor
    (D) groundnut, coconut
18. Match the columns and select the correct option.

	Column I		Column II
i.	Epicotyl	p.	Coconut water
ii.	Free nuclear endosperm	q.	Cotyledon in grass family
iii.	Scutellum	r.	Embryonal axis below the level of cotyledons
iv.	Formation and development of embryo	s.	Proembryo
		t.	Terminates with the plumule or stem tip
		u.	Embryogeny

	i.	ii.	iii.	iv.
(A)	r	s	p	q
(B)	u	q	t	p
(C)	t	p	q	u
(D)	r	q	s	p

19. The homologous structures in embryo of a pea seed and rice grain are
    (A) Cotyledons and Scutellum
    (B) Epicotyl and hypocotyl
    (C) Coleorhiza and Coleoptiles
    (D) Scutellum and perisperm
20. Select the CORRECT statement from the following.
    (A) Pericarp is the part of the seed which facilitates the entry of oxygen and water into the seed during seed germination.
    (B) Some seeds, such as black pepper and beet show presence of perisperm.
    (C) As the non-albuminous seed matures, its water content goes on increasing.
    (D) False fruits are those which develop only from the ovary.
21. Identify INCORRECT statements from the following and select the correct option.
    i. Edible portion in apple is thalamus.
    ii. Denaturation of enzymes may results in loss of viability of seeds.
    iii. Seedless fruits in grapes are formed due to double fertilization.
    iv. Perisperm differs from endosperm in being haploid tissue.
    Incorrect statements are
    (A) i and iii (B) i and ii
    (C) i and iv (D) iii and iv

22. Identify the labels p, q, r, s and t in the given figure of L.S. of an embryo of grass and select the correct option.



	p	q	r	s	t
(A)	Shoot apex	Radicle	Root cap	Coleorhiza	Plumule
(B)	Scutellum	Epiblast	Coleorhiza	Coleoptile	Root cap
(C)	Radicle	Plumule	Root Cap	Coleoptile	Scutellum
(D)	Hypocotyl	Epicotyl	Root Cap	Scutellum	Radicle

2.5 Apomixis and Polyembryony

23. Identify the INCORRECT statement.
(A) Production of hybrid seeds is costly.
(B) Hybrid seeds have to be produced every year.
(C) Hybrid seeds are too expensive for the farmers.
(D) If seeds collected from hybrids are sown, the progeny plants maintain hybrid characters.

Miscellaneous

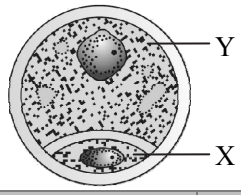
24. An angiospermic plant has to produce 88 viable ovules. How many meiotic divisions will be needed to produce equal number of female gametophytes by this plant?
(A) 88 (B) 22
(C) 44 (D) 132

25. If the haploid number in a flowering plant is 14. What will be the number of chromosomes in integuments, antipodal cells, embryo, endosperm and nucellus respectively?
(A) 14, 28, 7, 42, 21
(B) 7, 14, 42, 28, 14
(C) 28, 14, 28, 42, 28
(D) 42, 28, 14, 28, 14

26. Which is the most logical sequence with reference to the life cycles of an angiosperm?
(A) Cleavage – fertilization – grafting – fruit formation
(B) Pollination – fertilization – seed formation – germination
(C) Maturation – mitosis – differentiation – fertilization
(D) Germination – endosperm formation – seed dispersal – double fertilization

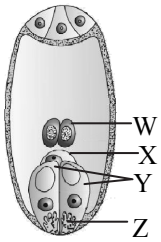
Problems To Ponder

1. Observe the given figure of two cells of pollen grain and select the appropriate option which describe labels 'X' and 'Y' correctly.



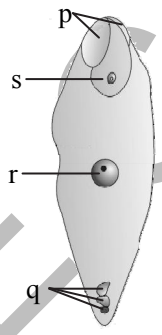
	X	Y
(A)	It is vegetative cell of pollen grain.	It is generative cell of pollen grain.
(B)	In some species, it divides mitotically and forms 2 male gametes before pollen grains are shed.	It has abundant food reserve.
(C)	It has irregularly shaped nucleus.	It is spindle shaped with dense cytoplasm.
(D)	It provides nourishment to developing pollen grain.	It gives rise to two male gametes by mitosis.

2. Identify W, X, Y, Z in the given figure of mature embryo sac and select the correct option.



	W	X	Y	Z
(A)	Eggs – fuses with one of the male gamete	Ovule – forms zygote after fertilization	Microspore tetrad – formed by meiosis division	Chalazal cells – present towards chalazal end
(B)	Antipodal cells – present towards micropylar end	Female gamete – Diploid part of embryo sac	Central cell – posses two polar nuclei	Synergids – it is a part of egg apparatus
(C)	Central cells – provide nourishment to egg	MMC – forms four megaspore	Antipodal cells – present towards chalazal end	Polar nuclei – they have special cellular thickenings
(D)	Polar nuclei – forms triploid PEN after fertilization	Egg – forms zygote after fertilization	Synergids – part of egg apparatus	Filiform apparatus – guides pollen tube into the synergids

3. Identify p, q, r, s in the given figure of fertilized embryo sac and select the correct option shown their ploidy.



	p	q	r	s
(A)	Degenerating antipodal cells – Haploid	Primary endosperm cell – Triploid	Zygote – Diploid	Synergids – Haploid
(B)	Degenerating synergids – Haploid	Degenerating synergids – Triploids	PEN – Diploid	Zygote – Diploid
(C)	Degenerating antipodal cells – Diploid	Primary endosperm nucleus – Triploid	Zygote – Haploid	Degenerating synergid cell – Haploid
(D)	Degenerating synergids – Haploid	Degenerating antipodals – Haploid	Primary endosperm nucleus – Triploid	Zygote – Diploid

4. Identify the ODD one out in each series and select the correct set of options.
   i. Monocarpellary, Syncarpous, Dithecous, Apocarpous
   ii. Funicle, Hilum, Tapetum, Micropyle
   iii. Epicotyl, Filiform apparatius, Plumule, Radicle
   iv. Pea, Wheat, Maize, Barley
   v. Apple, Strawberry, Mango, Cashew

	i.	ii.	iii.	iv.	v.
(A)	Syncarpous	Micropyle	Radicle	Barley	Apple
(B)	Dithecous	Tapetum	Filiform apparatus	Pea	Mango
(C)	Syncarpous	Hilum	Filiform apparatus	Wheat	Cashew
(D)	Apocarpous	Hilum	Radicle	Barley	Mango

Answer Key

Concept Building Problems

1.	(B)	2.	(C)	3.	(D)	4.	(B)	5.	(B)	6.	(B)	7.	(C)	8.	(B)	9.	(A)	10.	(B)
11.	(C)	12.	(C)	13.	(D)	14.	(B)	15.	(A)	16.	(B)	17.	(C)	18.	(D)	19.	(D)	20.	(D)
21.	(D)	22.	(C)	23.	(C)	24.	(A)	25.	(A)	26.	(A)	27.	(A)	28.	(A)	29.	(B)	30.	(B)
31.	(A)	32.	(A)	33.	(B)	34.	(B)	35.	(B)	36.	(B)	37.	(B)	38.	(A)	39.	(B)	40.	(C)
41.	(C)	42.	(A)	43.	(C)	44.	(C)	45.	(D)	46.	(D)	47.	(B)	48.	(A)	49.	(B)	50.	(B)
51.	(B)	52.	(D)	53.	(C)	54.	(B)	55.	(C)	56.	(C)	57.	(D)	58.	(A)	59.	(D)	60.	(B)
61.	(D)	62.	(A)	63.	(B)	64.	(A)	65.	(C)	66.	(C)	67.	(C)	68.	(C)	69.	(B)	70.	(D)
71.	(B)	72.	(B)	73.	(B)	74.	(B)	75.	(B)	76.	(C)	77.	(B)	78.	(A)	79.	(D)	80.	(D)
81.	(A)	82.	(D)	83.	(D)	84.	(B)	85.	(C)	86.	(D)	87.	(B)	88.	(B)	89.	(B)	90.	(C)
91.	(B)	92.	(B)	93.	(C)	94.	(A)	95.	(A)	96.	(A)	97.	(C)	98.	(B)	99.	(C)	100.	(D)
101.	(A)	102.	(A)	103.	(A)	104.	(C)	105.	(B)	106.	(D)	107.	(A)	108.	(B)	109.	(A)	110.	(B)
111.	(C)	112.	(A)	113.	(D)	114.	(C)	115.	(D)	116.	(D)	117.	(B)	118.	(C)				

Practice Problems

1.	(D)	2.	(B)	3.	(C)	4.	(C)	5.	(C)	6.	(A)	7.	(B)	8.	(C)	9.	(D)	10.	(D)
11.	(B)	12.	(A)	13.	(C)	14.	(A)	15.	(C)	16.	(B)	17.	(D)	18.	(C)	19.	(A)	20.	(B)
21.	(D)	22.	(B)	23.	(D)	24.	(A)	25.	(C)	26.	(B)								

Problems To Ponder

1.	(B)	2.	(D)	3.	(D)	4.	(B)

Hints

Concept Building Problems

2. Stamen is a part of male reproductive organ of a flower.

4. The number and length of stamens are variable in flowers of different species.

6. Label 'P' indicates pollen grains.
Pollen grains are formed by meiotic divisions of pollen mother cell (PMC) by the process called microsporogenesis. Pollen grains are haploid.

10. The cells of tapetum possess dense cytoplasm.

17. (A) Sprorogenous tissue is diploid.
(B) Tapetum of microsprorangium nourishes the developing pollen grains.
(D) Epidermis of microsporangium is followed by endothecium.
Sporogenous tissue occupies the centre of each microsporangium.

19. As sporopollenin cannot be degraded by enzyme, strong acids and alkali, it is useful in preserving pollen as fossil.

21. Honey is made by using nectar of flowering plants.

22. Tapetum provides nourishment to developing pollen grain.

23. Pollen grains of different species are incompatible, so they fail to germinate.

24. 1280 microspores are in 4 chambers of anther.
So, each pollen chamber has 320 pollens.
One microspore mother cell = 4 pollens
80 microspore mother cells = 320 pollens.
Thus, each pollen chamber has 80 microspore mother cells.

25. Dithecous anther $\rightarrow$ 4 pollen sacs
1 pollen sac $\rightarrow$ 1000 MMC
$\therefore$ 4 Pollen sacs $\rightarrow$ 4000 MMC
$\therefore$ 4000 MMC $\times$ 4 = 16,000 pollen grains
[1MMC = $\xrightarrow{\text{Meiosis}}$ 4 pollen grains]

27. Intine is a continuous layer made up of cellulose and pectin. The exine is a discontinuous layer with germ pores.

29. In the given figure, middle layers are incorrectly labelled as sporogenous tissue.

30. Pollen grains of rice and wheat lose viability within 30 minutes of their release.

31. Pollen grains of a large number of species can be stored in liquid nitrogen (–196°C) for many years. These stored pollen grains can be used as pollen banks.

37. Ovary in papaya, orchids and water melon contains more than one ovule, whereas ovary of mango contains one ovule.

38. Stalk of ovule is called as funicle.
Hilum is the region where body of ovule fuses with funicle.

47. Egg in female gametophyte is accompanied by two synergids.

50. Filament of an anther is always diploid (2n = 14). Antipodal cells of embryo sac are formed by meiosis of functional megaspore, thus antipodals are haploid (n = 7).

55. Cleistogamous flowers do not open at all. They are autogamous and hence produce assured seed set even in absence of pollinators.

58. Autogamy in a normal flower requires synchrony in pollen release and stigma receptivity.

60. Geitonogamy is the transfer of pollen grains from anther to the stigma of another flower produced on same plant.

61. In self pollination, variations are not produced and hence self pollination does not favor evolution.

62. Geitonogamy is genetically similar to autogamy since the pollen grains comes from the same plant.

65. In wind pollinated flowers, pollen grains are non-sticky.

73. Species of moth and *Yucca* plant cannot complete their life cycles without each other. Moth deposits eggs in locule of ovary, flower gets pollinated by moth. Larvae of moth come out of the eggs as the seeds develop.

79. Emasculation is done in the flowers of plants selected as female parent.

80. Pollen pistil interaction is a dynamic process involving pollen recognition which is followed by either promotion or inhibition of the pollen.

83. Syngamy is a fusion of first male gamete with egg. It results in formation diploid zygote which develops to form embryo. Triple Fusion is a fusion of second male gamete with secondary nucleus. It results in formation of triploid PEN (Primary Endosperm Nucleus) which develops to form endosperm. Since both male gametes participate in fertilization, it is called double fertilization.

84. Pollen tube bursts open to release the two male gametes. One of the male gametes fuses with the egg to form diploid zygote. This is known as first fertilization. The other male gamete fuses with the diploid secondary nucleus to form the triploid primary endosperm nucleus. As each of the polar nuclei is sister nucleus of the egg, it is called second fertilization.

85. Synergids bear special cellular thickenings at the micropylar tip called filiform apparatus which guides pollen tube into egg apparatus.

86. Double fertilization is a characteristic of angiosperms (e.g. Maize)

87. As a result of fusion of one male gamete with egg cell, zygote is formed.

92. Coconut milk represents free nuclear endosperm, where the division of PEN is not followed by cytokinesis.

94. During development of embryo, the zygote forms a wall around it and is converted into oospore. The oospore divides transversly to form large suspensor cell and small embryonal cell.

95. Pea is non-albuminous seed.

96. The hilum is a scar on the seed coat through which the developing seeds were attached to the fruit.

97. In angiosperms, endosperm nucleus is the product of triple fusion and is 3n (triploid).

98. Cashew is an example of false fruit.

100. Scutellum is the single cotyledon present in monocots.

102. Parthenocarpy is the production of fruit without fertilization of ovule. The fruit is therefore seedless like in banana.

108. Vivipary- When the seeds germinate within the fruit before the dispersal of fruits from parent plant, it is called viviparous germination.
Karyogamy- Fusion of two nuclei.
Syngamy-It is the fusion of first male gamete with egg. It results in the formation of diploid zygote which develops to form embryo. It is also called generative fertilization.

110. Apomixis is a special mechanism to produce seeds without fertilization.

113. Male plant × Female plant

$2n = 12$ ↓ $n = 6$ | $2n = 24$ ↓ $n = 12$

Endosperm ⟶ Male gamete (n) + Secondary nucleus (2n)

(3n) 6 + 24 = 30

114. 50 ovaries → 50 fruits
Total no. of ovules (50 × 50) = 2500 seeds.

116. Microspore and megaspore are formed by meiosis.

Practice Problems

2. When anther is young, the centre of each microsporangium is occupied by the sporogenous tissue.

3. No enzyme that degrades sporopollenin is so far known.

4. It is possible to store pollen grains of a large number of species for years in liquid nitrogen (–196°C).

9. (A) At maturity, a typical angiospermic embryo sac is 8 nucleated and 7 celled.
   (B) Egg apparatus is consists of one egg cell and two synergids.
   (C) The nucleus of the functional megaspore divides mitotically to form 2 nuclei, further two more sequential mitotic nuclear divisions result in formation of 8 nucleate embryo sac.

11. Majority of plants use biotic agents for pollination.
Geitonogamy is functionally cross-pollination which involves pollinating agents, but genetically it is similar to autogamy because pollen grains come from the same plant.

12. Monoecious plant (bisexual) bearing either bisexual or unisexual flowers can exhibit both autogamy and geitonogamy. In Dioecious (unisexual) plants, bearing only male or female flowers autogamy or geitonogamy is not possible and only xenogamy will be seen.

13. i. Pollination by water is quite rare in flowering plants.
    iii. In aquatic plants such as water hyacinth and water lily flowers emerge above the level of water and are pollinated by insects or winds.
    iv. In most of the water pollinated flowers pollen grains are protected from wetting by a mucilaginous covering.

14. When male and female flowers are present on different plants (dioecy) both autogamy as well as geitonogamy is prevented.

16. i. Pollen tube discharge its gametes in synergids.
    ii. In angiosperm triple fusion is necessary for the formation of endosperm.

19. In monocotyledons, cotyledon is known as scutellum.

21. iii. Seedless fruits in grapes are formed due to parthenocarpy.
    iv. The persistent nucellus is known as perisperm which is diploid.

23. If seeds collected from hybrids are sown, the progeny plants segregate and do not maintain hybrid characters.

24.
1 Megaspore Mother Cell $\xrightarrow{\text{Meiosis}}$ 4Megaspores (n)

$\xrightarrow{\text{3 degenerate}}$ 1 Functional Megaspore
↓
Female gametophyte

25. Integument is a diploid cell
∴ $2n = 2 \times 14 = 28$
Antipodal cells are haploid.
∴ $n = 14$
Embryo is diploid ∴ $2n = 2 \times 14 = 28$
Endosperm is triploid ∴ $3n = 3 \times 14 = 42$
Nucellus is diploid ∴ $2n = 2 \times 14 = 28$

Problems To Ponder

1. X : Generative cell
Y : Vegetative cell

4. i. The term Dithecous is related to anther, rest are related to pistil.
   ii. The term Tapetum is related to anther, rest are related to ovule.
   iii. Filiform apparatus is related to embryo sac, rest are parts of a seed.
   iv. Pea is a non-albuminous seed, rest are albuminous seeds.
   v. Mango is a true fruit, rest are false fruits.